insects. I have tried a few experiments along this line some years back, but I was always plagued by bacterial contamination. I dislike the idea of using antibiotics, as this procedure could upset the metabolism of the plant. Raising the plants in a germ-free environment seems to be the best way to go.

WAYNE MRAZEK (2270 Grayson, Anaheim, CA 92801) replies: Enclosed is a picture of *Drosera regia*. I am cultivating two plants, one growing larger, the other apparently going dormant. I am growing them in live sphagnum moss, and have been told by a friend in England that it is as easy to grow as *D. capensis*.

GREG RUSSELL (71 Melrose Dr., Flindersview, Qld. 4305, Australia) reports: We have started a society here in Ipswich. There are twenty members at present but all are good workers. We hope to produce a newsletter to promote carnivorous plants and our club throughout Queensland. Articles such as yours would be very valuable to us if we could use them. We have put on displays for orchid clubs and we have created some interest. Through activities such as these, we should boost our membership. As the C.P.N. of Australia has fallen down (I have not had a copy since Vol. 6), maybe our newsletter will bring collectors together again.

TOM STORY (1112 Klengel St. Antioch, CA 94509) sends us a newspaper article reporting the increase in pilfering of plants from botanical and private collections. It seems that the thieves know exactly what they are after since the best and rarest orchids and carnivorous plants are taken. Many of the famous collections in Great Britain are now closed to the public or greater restrictions are imposed on visitors. In this report, the Royal Botanic Gardens at Kew reported some carnivorous plants were taken.

The Evolution of Carnivorous Plants

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It would be nice to have a time machine so as to see exactly how CP evolved. None being at hand, one must turn to the fossil record, but unfortunately it is very sparse on the subject. Droseraceae pollen first appeared in the Miocene period (26 to 7 million years ago), and *Aldrovanda* is reported from the Eocene (58 mya) of south England (Raven & Axelrod 1974). There is a report of *Aldrovanda* seeds having been found in interglacial deposits of Europe (Nikitin 1927) but these are quite recent. They are identical to modern seeds and thus shed no light on the evolution of this genus.

The aforementioned fossils indicate that CP are at least as old as the Eocene but not necessarily exactly that old, as earlier fossils may not have been preserved or not yet discovered. Ancestral forms are hidden somewhere in the sediments, as CP could not suddenly appear fully-developed in their present form. These ancestral forms would not always be recognized, as they would be without definitive CP characteristics during their initial period of evolution.

Since CP are flowering plants (angiosperms), they can be no older than the Cretaceous, 135 to 75 mya, when angiosperms first began to evolve. Angiosperms diversified rapidly during the Tertiary, 75 to 2 mya, and most likely this is when CP first appeared on earth. The prey of the plants, generally insects, all precede angiosperms by up to several hundred millions of years, so no assistance can be had from them in fixing a date of CP origin.

Attempts are often made by botanists

to rank species in a phylogenetic tree based on "primitive" versus "advanced" characteristics. A number of fallacies usually detract from these attempts. Firstly, no two botanists will necessarily agree on what is primitive and what is advanced. One man's "primitive" is another man's "degenerated from advanced stock." The same characteristic of a plant can be given different weights by different botanists. One botanist may consider the characteristic to be a major part in classifying the species, while another considers it to be unimportant. Thus without a good fossil record, one cannot provide a definitive phylogenetic tree of CP, and one cannot establish such a tree based on comparisons between CPs. (Fig. 1).

When considering CP evolution, allowance must be made for the effect of continental drift as well. When angiosperms first began to evolve, there existed on this planet only two supercontinents, Laurasia and Gondwanaland. Laurasia, in the northern hemisphere, consisted of North America, Europe, and Asia. Gondwanaland, in the southern hemisphere, was formed from South America, Africa, India, Australia, and Antarctica.

Laurasia and Gondwanaland began to break apart in the Cretaceous. By the Eocene, India was an island floating north towards a collision with Asia. Africa had separated from South America. South America was still connected to Antarctica, which in turn was attached to Australia and New Guinea (fig. 2). Not until late in the Tertiary were all the continents separate from each other and assuming their present positions. The contact between North and South America was intermittant, Central America rising above and falling below water level several times throughout the Tertiary.

By considering present-day CP distribution together with continental drift, one can speculate when a particular CP family might have evolved. It seems likely, for example, that the Byblidaceae and Cephalotaceae, endemic to Australia, evolved after that continent was isolated from the others by drifting, after the late Eocene.

In the Lentibulariaceae are the genera *Pinguicula* and *Utricularia.* The latter has a worldwide distribution. It is difficult

Figure 1. Unfortunately this is not a fossil *Drosera* leaf. Collected from Eocene sediments of British Columbia, Canada, it is a pine needle with dendrites (outgrowths of minerals which crystallized on the fossil needle). Paleobotanists have been fooled by less subtle pseudofossils. Photo by the author.

to say whether this is because it evolved before the supercontinents split up or because aquatic plants can be dispersed more easily than terrestrials. *Pinguicula* is confined to the northern hemisphere, with a dip into South America. It seems probable that it evolved in Laurasia during the Tertiary, and spread to South America quite recently when Central America rose.

The Sarraceniaceae are confined to North America and northern South America. Based on continental drift, they would have appeared after Laurasia broke up in the Tertiary, probably some time after the Eocene. By then North America was separated from Europe, isolated the ancestral stock and confining it to one continent. Dispersal to South America would have followed much later.

The Droseraceae are worldwide as a whole, suggesting an origin in the Cretaceous or early Tertiary, before the continents had drifted very far from each other. *Aldrovanda,* being aquatic, may have travelled with greater ease than its fellow genera. It ranges from Europe to Africa, India, Japan, and northern Australia. *Drosophyllum* is confined to the Iberian peninsula, with apparently local dispersion to Morocco, unrelated to continental drift.

Dionaea is, of course, endemic to southeastern North America. The difficulty here is to determine whether this endemism is a result of recent evolution or because the genus is a relict and formerly had a wider distribution.

Drosera is worldwide, suggesting an early origin in the Cretaceous or Tertiary.

Nepenthes is found from northern Australia to Sri Lanka and Madagascar. It may well have originated in Gondwanaland, as Australia, India, and Madagascar made up the northern coastline of that supercontinent. This suggests

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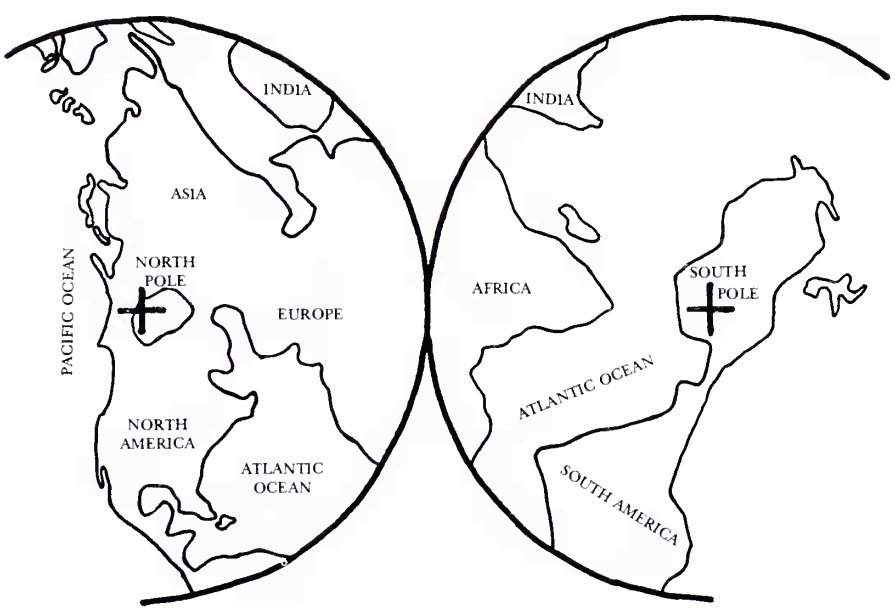

Figure 2. The world as it appeared in the early Tertiary. Northern Hemisphere is at left, Southern Hemisphere at right. Crosses indicate the poles.

HOW EXCLUSIVE ARE CARNIVOROUS PLANTS?

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We tend to think that carvinorous plants belong to an exclusive club. Alone amongst the rich variety of plant life, only a few hundred fungi and flowering plant species are thought to be carvinorous, and of these we are mostly familiar with the flowering CPs. It is hardly surprising — the bizarre and often highly sophisticated traps of these plants have set them far apart from anything else we know of. Or have they?

Charles Darwin (1875) suspected that many plants bearing adhesive glands might turn out to be carnivorous, amongst them *Saxifraga umbrosa, Primula sinesis, Pelargonium zonale, Erica tetralix,* and *Mirabilis longifolia*, but (uncharacteristically) he did not take his suspicions any further. Probably the most influential review of the likelihood of carnivory outside our traditional concepts was Francis Lloyd's opening chapter in his classic book *The Carnivorous Plants*, published in 1942. In this he briefly mentioned a whole host of various insect-trapping devices in a quite extraordinary range of plant species — and yet he either dismissed or passed over all of them. It is probably thanks to Lloyd that we have settled for such a meagre number of carnivorous plant species.

One outstanding problem, though, is to define exactly what a carnivorous plant is, and I'll return to this question later on. What I want to consider first is the *potential* scope for widening the carnivory membership in the plant kingdom.

Adhesive traps

One of the commonest carnivorous plant traps is the sticky leaf trap, which glues its prey down while digesting it. This type of trap is present in many flowering plants (*Drosera, Drosophyllum, Pinguicula, Triphyllum*) and also hundreds of fungal species. But there are many more flowering plants which bear sticky hairs on parts or the whole of their shoots, as pointed out by Darwin; a few examples are given in Table 1. Aha, you might say — these sticky hairs are there to protect the plant from herbivorous insect predators, particularly crawling ones. Yes, this is no doubt true, but then the same equally applies to *Drosera, Drosophyllum* et al.; the essential difference, though, is that the plants in Table I (and others like them) have not been properly investigated. However, this is not true for a few forgotten species.

Apart from Charles Darwin, most of the early classic scientific work was carried out by Germans, so it came as a great surprise to me to stumble upon an intriguing Italian paper in *Biological Abstracts* entitled "Ricerche anatomofisiologiche sulla *Petunia violacea* e sulla *Petunia nyctaginiflora* come piante insettivore." Even

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Nepenthes had a coastal distribution during the Cretaceous.

Having written all this, I remind the reader that the foregoing is speculative and based on the assumption that CP distribution was determined mainly by continental drift. Long distance dispersal may have played a part in the matter. One wonders though, that if *Drosera* was spread about in such a manner, why then were *Byblis* and *Cephalotus* not so affected.

REFERENCES

Nikitin, P. A. 1927. Interglacial occurrence of *Aldrovanda vesiculosa* L. New Phytologist 26:58-59.

Raven, P. H. and Axelrod, D. I. 1974. Angiosperm biogeography and past continental movements. Ann. Missouri Bot. Garden 61:539-673.